Infogame users manual (Rev. 2.1)

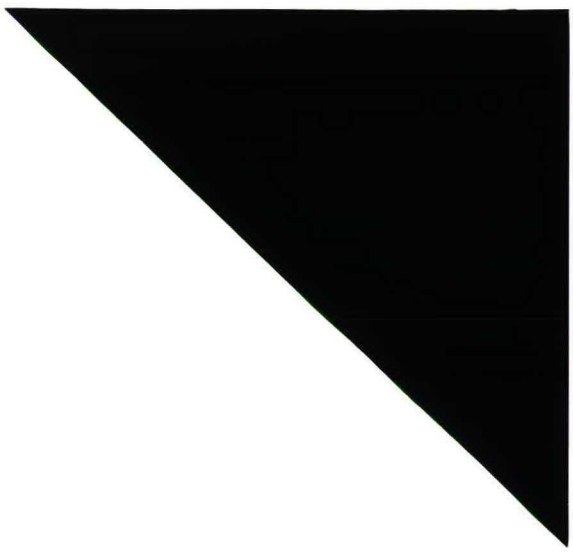
Casimir, R.J.

Publication date:
1994

Research Memorandum

Faculty of Economics and
Business Administration

Tilburg University



INFOGAME
USERS MANUAL

R.J. Casimir

FEW 676

Communicated by Prof.dr.ir. C.A.Th. Takkenberg

INFOGAME

USERS MANUAL

Rev 2.1 September 1994

Rommert J. Casimir
Tilburg University
P.O Box 90153
5000LE Tilburg, Netherlands
CASIMIR@KUB.NL

FOREWORD

This edition of the Infogame Users Manual describes version 2.1 of Infogame. The main changes from version 1.3, described in "Reeks ter Discussie" 89.07 are:

- Chapters 4 and 5 are combined. Programming examples in DBASE3 have been deleted, and a section on handling report data in Lotus 1-2-3 has been added.

- Chapter 6 (formerly chapter 7) now addresses the game administrator rather than the operator. The availability of a hard disk or network server is now assumed. The section on data changes has been removed to a separate game administrator's manual.

- The labour market model has been changed (see sections 2.6 and 3.12)

- Customers who cannot be served in time now cancel orders on their own initiative. When production is started on a specific order, delivery is always accepted.

- A technology always uses a single machine.

- The structure of the report file has been changed (see chapter 4).

- The number of days in a month (20) and a quarter (60) are now fixed instead of variable.

- Events occurring at the end of a month are now distinguished from events occurring at the start of the next month.

Infogame is a medium-sized set of programs (about 5000 lines) in Turbo-Pascal Rev 6.0 for the IBM-PC or compatible with 640 K memory. For educational and research purposes, a free copy of Infogame, containing the programs in .EXE form and the data in ASCII format, is available from the author.

1 INTRODUCTION

Infogame is a game for teaching the design and implementation of information systems. It can be played as a regular game with up to twelve players or player teams, but it may also be used as an exercise by a single player.
^Pt contains elements from two types of games commonly used in management education: *simulation games*, where players take the role of middle managers making decisions in a limited area, such as production, and results are computed independently for each player or team, and *management games*, where players assume the role of top managers unconcerned with the company's day to day problems, and results are primarily determined by competition with other players. In Infogame, operations are simulated in detail, and players get reports on those. However, players take on the role of top managers; they give instructions on operations in the form of rules, which may be interpreted as orders to middle management.

To clearly identify the difference between the three types of game we describe the way production is handled:

In *management games*, global production orders are given, such as *produce 10,000 tons of product X during this period* or *during this period, produce product X with 50 workers and 2 machines*. The results are also in a global form, such as: *9500 tons of product X were produced during this period.* Differences between instructions and results can be attributed to a global model, such as a LP model.

In *simulation games* that model a *process industry*, players decide on production per day or per hour and results are reported on the same time scale. In simulation games that model a *job shop*, players decide what job should be executed next when a state change (end of a job, arrival of supplies, repair of a machine, etc.) allows execution of a new job. Results of jobs are reported separately after the end of each job. In both types of simulation games, data are aggregated to determine the player's success.

In *Infogame*, which models a job shop, production is controlled by a rule stating that a given amount (the *order quantity*) of a product must be produced when the stock falls below a given level (the *reorder level*) and the requisite resources (materials, machines and manpower) are available. For each job, results are reported in detail. In an Infogame-like game that simulates a process industry, a rule would compute daily production from such parameters as size of stocks, number of operators available, and condition of installations.

Because both rules and other top management decisions (such as investment decisions) influence operations (for example, an incorrect relation between order level and order quantity will cause stockouts or excessive inventories), the player needs reports on actual operations. The contents of those reports are not defined in advance; the player can choose which events should be reported. For example, for most purposes it is not necessary to report both the allocation of materials at the start of a job and the use of materials at the end of a job.

The detailed reports, which may contain over 1000 records for a game round, would flood the player with detail. Consequently, an information system must be designed to process the raw data into usable information. This may be an accounting system that computes balance sheets and profit and loss statements or a sophisticated decision support system that analyzes production and marketing data. We do not suggest a "best" approach. Some examples are given in chapter 4.

Apart from the data provided by the game program, the player receives data on the environment from the game administrator at the start of a series (for example, attribute values of suppliers and machines). The only dynamic elements in the environment are the growth of the market and the labour force. No new markets, products, materials, machines or technologies are introduced during a series. In contrast to most conventional management games, Infogame does not start with going concerns. Players start new companies with a cash capital of 10 million ECU. In the first round, players must base decisions on the environment data: a prime reason not to start with going concerns was

that we did not want to influence information system design by the form and contents of historical data. However, a game administrator who prefers to start with going concern can run the first quarter(s) according to a fixed scenario. Players must also decide on company structure: Infogame accommodates single-product companies as well as diversified and integrated firms. This was an additional reason to start without going concerns: the complexity of the production system influences the complexity of the information system, and the choice of the level of complexity is left to the players.

How to use this manual

This manual is organized as follows:

Chapter 2 describes the system simulated by Infogame; it provides background information for making decisions in the game.

Chapter 3 describes how decisions are actually entered; it may be necessary to turn to chapter 2 to find the implications of decisions or to chapter 5 to find the relevant data.

Chapter 4 describes the output from Infogame. If the player wants to make a decision on the data that should be reported, this section should be consulted before decisions are entered. Alternatively, the player can ask for all data and subsequently study section 4 with the report at hand.

Chapter 5 describes the standard set of data provided with the game. If the game administrator actually changes data, this section should be tailored to the new data set. Because the game administrator can change a large number of parameters, the wording in the manual may be intentionally vague (for example: *there are up to five industries*).

Chapter 6 is intended for game administrators and players who play Infogame as an exercise; it can be skipped by players in a regular playing session.

2 OUTLINE OF THE GAME

2.1 Definitions

Each player or player team manages a company producing goods or services in up to five competitive industries (services are industries were no stocks can be held). There is no competition between products in different industries. Consequently, if the number of players is less than or equal to the number of industries, and each player specializes in a single industry, there is no competition. The game administrator may model industries after real-world industries, such as the building industry, which produces to order only, the detergent industry, where advertising costs are high, the aerospace industry with a complicated production system, etc. In this manual, we only mention the abstract characteristics of industries and production processes: it is up to the player to identify an industry that can produce both for stock and to order, has high setup costs, and demand for a wide quality range, with the car industry.

A company employs a number of workers, it owns a number of machines of different types, it markets a number of products, and it buys, stocks and uses materials of different types. In each industry, one or more production technologies can be adopted. A technology specifies the quality of a product and the resources (machines, labour, and materials) needed to produce it. For example, in an industry there may be three technologies A, B and C with the following characteristics:

technology	production characteristics	product quality
A	capital-intensive	low
B	labour-intensive	low
C	labour-intensive	high

Production is done in batches; Infogame simulates job shops rather than process industries. All materials needed for a batch must be present at the start of a job, and

finished products become available only when the job has been finished. Consequently, when the batch size is large, a large stock of materials is needed and the average stock of finished products will also be large. On the other hand, if a technology with a long setup time is chosen, a small batch size entails high setup costs.

2.2 Time

In contrast to conventional management games, where all events during a gaming round are assumed to occur at the same moment (say, the start of the first day of the year), Infogame maintains an internal clock to time all events in a simulated period. However, it is not a real-time game because the player cannot directly influence events after the start of a round. A game round is equivalent to a quarter, containing 60 working days. Days are numbered continuously; for example, 362.14 indicates a moment in the third day of the third quarter of the second year. Most events can occur at any time of the day. Payments to suppliers always occur at the start of a day. Inventory taking occurs at the end of a day. Salary and interest payments occur at the end of a month (i.e. at times 19.99, 39.99, etc.. Changes in the number of employees and advertising outlays occur only at the start of a month (i.e. at days 0, 20, 40 etc.).

Long-term planning decisions (investment, employment, and marketing decisions) are made by the player; short-term scheduling decisions (ordering materials, starting a production run, delivery to consumers) are made by the game program. So players play the role of top managers, and the decisions of middle management and operating personnel are programmed. This "program" is defined in the simulation code.

Examples of rules are:

If a resource becomes available, the oldest production order waiting for that (and only that) resource will be executed.

If the stock of materials falls below the player-specified reorder level, an amount equal to the player-specified order quantity is ordered.

The primary report contains records on states and events in the order of the time when they were made. For example, if a sale was made at 23.57, a machine was repaired at 23.61 and a new sale was made at 23.64, the events are reported in that order. The primary report reflects the outcome of strategic, tactical and operating decisions. It is up to the player to find the information necessary for his decisions in the next round.

2.3 Industry characteristics

An industry in Infogame operates in one of the following modes:

Production for internal use only

The product is a material that cannot be sold on the market, but may be used in the production of other materials and/or consumer products. Production of materials is governed by the rules for acquisition of materials. For example, if the reorder level for material "MAT160" is set to 5000, and the order quantity is set to 2000, a production order for 2000 units of an internally produced material with quality index 160 is given when its stock is below 5000. When a job has been finished, the material produced is added to the stock of materials. A detailed description is given in section 3.10.

Whereas the quality index in other industries is a rough index of consumer acceptance, quality of a product used as a material should be exactly equal to the specified quality of the material. For example, if a material with quality index 120 is specified, a product with quality index 119 or 121 cannot be used. An example can be found in the car industry: a consumer may prefer a larger model for the same price, but parts for a specified model should conform to exact specifications.

Production for stock only

A production order is placed when the stock of finished products falls below the reorder level. When a production order is finished, the amount produced is added to the stock. Orders that cannot be filled from stock are ignored; consumers just disappear or switch to competing products. For this mode, the reorder level should be positive; otherwise production will never start.

Production to order only

When a customer orders a product, a production order for the amount ordered is placed. In this context, "amount" is equivalent to "size": the demand for a building with a height of 320 feet cannot be filled by two buildings with heights of 300 and 20. When an order is finished, it is delivered to the customer. The consumer can annul the order if the promised delivery date has passed, but only if production on that order has not yet started.

Production for stock or to order

Production is for stock, but customer orders that cannot be met from stock are retained. The amount produced is added to the stock, and existing back-orders are filled before the product is made available to new customers. Production orders are placed as long as the stock is below the reorder level. With a zero or negative reorder level, production is started only when there is a sufficient order backlog.

In the data given in chapter 5, production mode can be determined from the variables *stock possible* and *maximum delivery time* according to the following table. It should be clear that immediate delivery is impossible when no stock can be held.

	Maximum order time = 0	Maximum order time > 0
Stock possible	Production for stock	Production for stock and to order
Stock not possible		Production to order

2.4 Sales

Potential sales in an industry are determined by the formula:

$$S = N.O \frac{60}{I}$$

N Number of consumers

O Average order size

I Interarrival time of each consumer

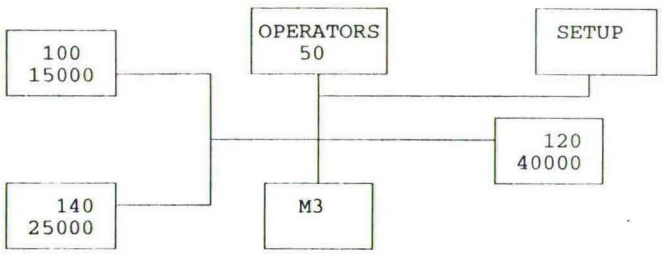
Irrespective of the competition, a product cannot be sold to a consumer if the price is too high. Consumer number 1 only accepts products with a price equal to or below the base price, consumers with a higher number accept higher-priced products. A product is only considered by a consumer if the promised delivery date is acceptable. Consequently, in an industry with production for stock only, products offers are made only if the consumer demand can be satisfied immediately from stock. Moreover, the product must be known, either by advertising or by previous sales to the consumer or a member of his *reference group*, a consumer with a slightly higher or lower number. Consequently, advertising is necessary for new products and for products aiming at a new class of consumers. When products are compared, price, consumer credit, quality and expected delivery time are taken into account. However, the selection also involves a random factor. If, in an industry with production to order, the promised delivery date is exceeded, the consumer annuls his order and returns to the market, but he will not try the same product again. Repeated annulments will damage the reputation of a product. Pertinent data are given in section 5.3

2.5 Production

For each product, one or more technologies must be chosen (see 3.7). Technologies that produce the same product must have the same quality index and must be in the same industry. For marketing purposes, one technology may be used to produce different products. Technology data are defined by the game administrator. Actual values are given in section 5.4

Variable	Description	Example value
Name	A unique name for the technology.	TRADB
Industry	Name of the industry where the technology is used.	TRAD
Machine	Type of machine needed for production.	M3
Quality	Quality index of a product produced with this technology.	120
Operators	Number of fully productive operators needed for operation at full capacity.	50
Capacity	Number of units produced in a quarter at full capacity.	40 000
Setup	Time needed to start up production after a stop or a change in production setup.	2
Material	Type and amount of each material needed for production at full capacity during a quarter.	15000 of quality 100, 25000 of quality 140

Maximum production and amount of materials needed (for maximum production) are flow data for a game period; the other data are state data. In this example, 40,000 units of a product in industry TRAD with quality index 120 can be produced if the company employs 50 fully productive operators, operates a machine of type M3, and has sufficient materials of quality 100 and quality 140 in stock. This technology can be represented as follows:



Production is done in batches. In industries with production for stock, scheduling is determined by two variables: *reorder level* and *order quantity*. Whenever the stock (including orders in process) is lower than the reorder level, an order to produce a batch with the size of the order quantity is entered into the order queue. An order in the queue is executed when it is the first for which all resources are available. Consequently, production will be interrupted if the reorder level is lower than the order quantity. Figures 1 and 2 show the size of stocks and orders over time.

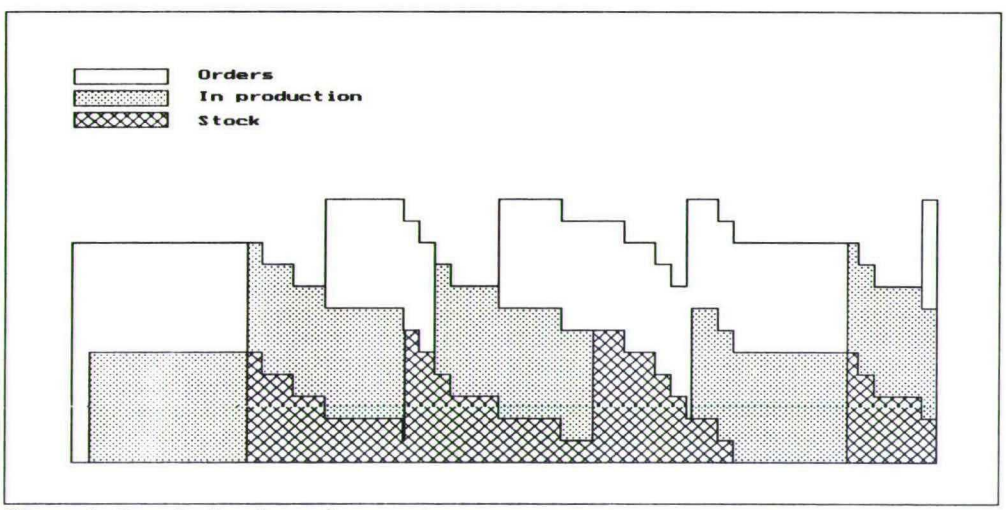


Figure 1: Reorder level > order quantity

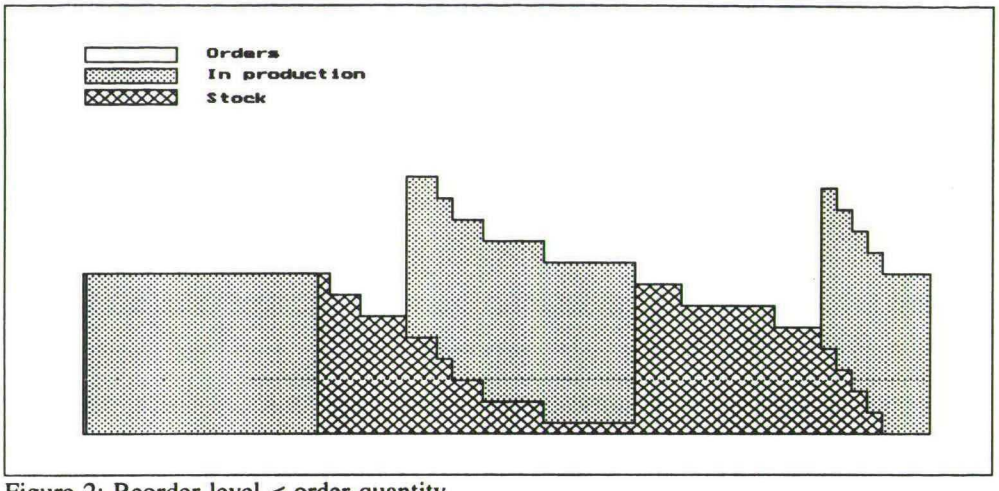


Figure 2: Reorder level < order quantity

For industries with production to order, an order from a consumer is entered in the queue of production orders when it is received. The variables "order quantity" and "reorder level" are not used. The first order from the queue for which all resources are available is executed. Figure 3 shows the production process.

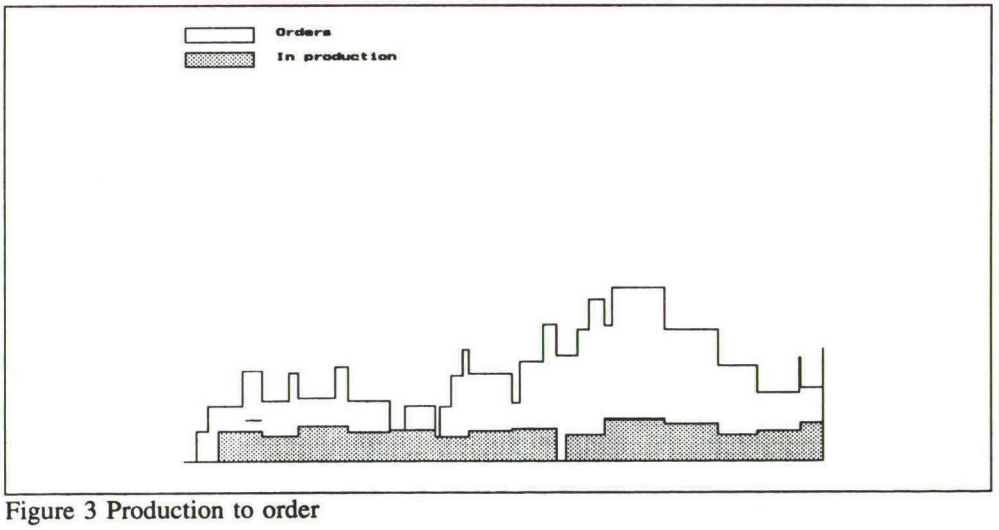


Figure 3 Production to order

The player also sets the maximum time allowed for production of a batch, a variable that is well known in computer operating systems (maximum job time). In industries with production to order, an order is not executed if production time would exceed the specified maximum time; in industries with production for stock, the batch size is reduced to what can be produced in the specified time.

Production is started only if enough materials are available; partial production of a batch because of lack of materials is not possible. When production would be stopped because lack of materials, and no materials have been ordered, this will be done.

Mathematically, the required amounts of materials are defined by the condition:

$$\forall i \in M: q_i \geq \frac{r_i B}{C}$$

q_i Stock of material of type i.

r_i Materials of type i needed for production at full capacity.

M Set of types of materials.

B Batch size.

C Production capacity for a quarter.

Example	r_1	r_2	B	C	min q_1	min q_2
	20 000	10 000	1 000	40 000	500	250

If sufficient materials are available, net production time in days (without setup time) for a batch is the lower of the maximum time allowed and batch size divided by the actual capacity. Actual capacity is the product of full capacity and the minimal proportion of actually available to specified resources. It is never higher than full capacity.

This is expressed by the formula:

$$t=\min\left(\frac{60B}{\min\left(\frac{w}{W},1\right).C},x\right)$$

t Net production time for a batch in days.
B Batch size.
w Number of fully productive operators.
W Number of operators needed for production at full capacity.
C Production per quarter (60 days) at full capacity.
x Maximum time specified.

Example	B	w	W	C	x	t
	1000	100	150	30 000	2	3
	1000	100	50	30 000	1	2
	$3000_!$	100	100	30 000	5	5

! Specified batch size. Actual batch size with production for stock is 2500. Production will not be started with production to order.

The variables *batch size* and *maximum time* can be combined in three ways. First, maximum time can be set so high (say at 60) that it never limits production time. Second, for an industry with production for stock, it can be set so low that the batch size is always determined by the maximum time allowed. In this case, batch size is computed by the formula:

$$B=\frac{x.\min\left(\frac{w}{W},1\right).C}{60}$$

Third, batch size can be used to determine regular production time, and maximum time is used as a *safety valve* to prevent the start of a job with too few operators, just as maximum job time is specified by a computer centre user to prevent the waste of valuable resources because of a program bug.

If a production job immediately follows another job producing the same product with the same machine, no extra setup time is needed. In all other cases, for example if production is stopped for any time, or if a machine must be repaired, setup time is added to net production time. Consequently, unreliable machines not only directly decrease capacity, but they also increase setup time.

Total production time is computed by the formula:

$T = t$	If production is continued immediately with the same machines.
$T = t + s$	Otherwise

T	Total production time
t	Net production time
s	Setup time

The mechanism that selects orders for production is derived from operating systems practice. When the stock is below reorder level (in industries with production for stock) or a consumer order is received (in industries with production to order), a production order is entered into a queue. Whenever an order is added to the queue or a resource has become available (for example, materials or machines have arrived, machines have been repaired or a production job has been finished), the order queue is searched sequentially for the first production order that can be executed with the resources. Resources are allocated to this job, and the queue is searched for orders that can be executed with the remaining resources. Consequently, when many machines are present, many jobs can be executed in parallel. This may result in an increase in setup time.

2.6 Labour

A company can either engage unemployed workers or it can hire employees from other companies. Employees prefer a company with a higher wage and dislike a company with a history of mass dismissals. A company having too many employees can stop hiring and hope that employees leave voluntarily. If the number of employees is still too high at the end of the quarter, the superfluous workers are dismissed with one or more

months of redundancy pay. If the number of employees is between the specified minimum and maximum, neither hiring nor firing will occur. At the start of the game, a number of unemployed workers are available. Later on, new workers will enter the labour market if unemployment is low and demand for labour is high and unemployed workers will leave the market if unemployment is high.

All workers in a company have the same productivity index, a number between 0 and 1, that denotes the productivity of a worker as a fraction of the productivity of a standard worker. The productivity of employees who are new to a company is a constant. The productivity of workers already with a company increases with the product of the learning factor and the productivity gap (1 minus the productivity index). The new value of the productivity index is equal to the weighted average of the productivity indices of old and new workers. Mathematically, productivity is defined by:

$$p_i = \frac{N.q + W.(p_{i-1} + L.(1 - p_{i-1}))}{W + N}$$

p_i Productivity index for period i
q Productivity of new workers
N Number of new workers
W Number of workers already employed
L Learning factor

Example	1	0	50	0.5	0.3	0.5
	2	40	10	0.5	0.3	0.62
	3	45	5	0.5	0.3	0.7106

2.7 Company design

Because all companies in Infogame start from scratch, players are free to decide which type of company they want to operate. Company types are:

Single-product company

The success of a single-product company mainly depends on the choice of product and technology. Its operation entails two relatively simple tasks: Ensuring efficient production and selecting an optimal marketing mix. Information processing in this type of company is simple, as there is no need to compute results for different products or technologies.

Diversified company

A diversified company produces more than one product and/or applies more than one technology. If the relation between technologies and products is one-to-one, and each technology uses a different type of machine, information processing is still relatively simple. However, if products are produced with several technologies, and/or share machines, intricate planning, scheduling, and accounting problems arise.

Integrated company

An integrated company produces materials as well as final products. This poses problems in planning and in monitoring the overall efficiency of the production process, especially if the materials produced within the company are used in several products. Specialists in logistics may use the model of the integrated company to demonstrate the use of MRP and similar techniques. Accountants will stress the importance of the correct valuation of stocks of intermediate products.

3 HOW TO PLAY

3.1 Input formats

Infogame is normally operated in an interactive way: players enter decisions from the keyboard; they can correct inputs until the game administrator signals the end of the round.

There are three types of input:

a) Selection: Selection of an option from a list.

b) Set selection: Selection of a set of options from a list.

c) Table filling: Filling a table on the screen.

During selection and set selection the screen contains a list of options. During table filling a table appears on the screen. Fields that cannot be changed are protected, and cannot be reached by the cursor. Columns are headed by explanatory captions. In this way, the probability of input errors is minimized. In all cases, a summary explanation of the instruction is given in a foot line. The following keys may be used:

Character		Selection	Set selection	Table filling
→	Right arrow	Next item	Next item	Position right
←	Left arrow	Former item	Former item	Position left
↑	Up arrow			Row up
↓	Down arrow			Row down
←-	Backspace		Remove selection	Remove left character
→|	Tab			Column right
|←	Back Tab			Column left
Ins				Insert space
Del				Delete character
←┘	Enter	Select	Select item	Go to start of next row
F1		Help	Help	Help
F9		End selection	End selection	End filling
ESC		End selection	End selection	End filling

3.2 Starting the program

Normally, the game administrator provides a login program that automatically assigns the player to a subdirectory with the same name as his company, and starts the INFOGAME program. See chapter 6 for details. After the program start, a password must be entered by filling a table. For a new company, the same password must be entered both in the ENTER and in the VERIFY column. All characters are echoed with "X" on the screen. The program stops after three unsuccessful attempts to type the correct password.

ENTER	VERIFY

```
VERIFY PASSWORD
```

For an existing company, the password must be entered in the ENTER column:

ENTER

```
ENTER PASSWORD
```

When the correct password has been entered, one of the following options is selected:

```
REGISTER INVEST SCRAP DESIGN REMOVE PRODP MAT SUPPL EMP BANK REPAY CREDIT

CHOOSE INSTRUCTION
```

The input session is ended by pressing F9 or ESC. Subsequently the Infogame program can be restarted to correct data. Results are computed when data are entered for all companies.

3.3 Instructions

The following instructions can be selected:

Instruction	Description	Default	Section
REGISTER	Define output signals	U	3.4
INVEST	Invest in machines	N	3.5
SCRAP	Scrap machines	N	3.6
DESIGN	Design a product	N	3.7
REMOVE	Remove a product	N	3.8
PRODP	Define product characteristics	U	3.9
MAT	Set parameters for materials	U	3.10
SUPPL	Choose suppliers	U	3.11
EMP	Define terms for employees	U	3.12
BANK	Ask loans	N	3.13
REPAY	Repay loans	N	3.14
CREDIT	Accept credit and set credit terms	U	3.15

The default code determines what will be done when the instruction is not selected:

U Unchanged: the entry from the former period is copied.

N No action: nothing is entered.

For example, if no **SUPPL** instruction is given, suppliers for materials are not changed; if no **DESIGN** instruction is given, no new products are designed.

3.4 Define output signals (REGISTER)

The **REGISTER** instruction allows the player to define the contents of the output file. To this end, the player first uses set selection to select the events that will be reported and the inventories that will be taken.

The cost of reporting each event or inventory is defined by the game administrator and supplied to all participants (see 5.7). A description of events and inventories, and the syntax of the resulting output file is give in chapter 4. The list of events and inventories appears on the screen as:

```
matorder mat nomat alloc use paymat order prodqueu prodord prodrdy
deliver nodeliv salepay salary advert removep install noinst machall
machfree scrap defect repair interest reploan hire fire leave
assignw freework hirecost firecost mats ps machw machnu pers ops


WHAT REPORTS
```

Some data are redundant. For example, it is not necessary to report both the use of materials when a job is started (alloc) and when it is finished (use). If one or more inventories have been selected, report frequency is defined in a table instruction. In addition to inventories listed in this table, the daily cash balance and the total accounting costs are reported without cost. If the **REGISTER** instruction is not used, or no items have been selected with the instruction, the report only contains the cash balances. The format of the instruction to define report frequency is:

REPORT	FREQ
mats	10
ps	10
machw	10
machnu	10
pers	10
ops	10

```
SET REPORT FREQUENCY
```

Report frequency is given in days. For example, "mats 10" means that the stock of materials is inventoried every 10 days. As there are no discrepancies between inventory data and event data because of frauds, waste or errors, the only reason to collect inventory data as well as event data is to check on the information system. For example, product stock (ps) can be computed from production and delivery data if these are recorded. On the other hand, if product stock and deliveries are recorded, production may be computed from these data.

3.5 Invest in machines (INVEST)

When a company wants to purchase machines, it defines the machine type and the number of machines in an INVEST instruction with the following screen format:

MACH TYPE	NUMBER	REMARKS
M1	5	
M2	7	
M3	2	TYPE UNKNOWN

INVEST IN NEW MACHINES

For each machine type the following data are given (see section 5.5 for data). Actual delivery times, failure times and repair times are drawn from a negative exponential distribution.

Attribute	Description
Machine	Unique name of the machine type
MTTD	Mean time to deliver in days
Repair	Cost of repair per day
Price	Price of one unit
MTBF	Mean time between failures in days
MTTR	Mean time to repair in days
δ	Decrease in MTBF and increase in MTTR per quarter

A machine will be installed only if it can be paid at the moment of delivery. When it is installed, it is paid immediately, it is given a sequential number, which will henceforth be used to denote this machine, and it can start producing. When alternative technologies are available to produce a product, cost and reliability of the machines employed may be a decisive argument. Another reason to choose a particular set of technologies may be that they use the same machine. Such decisions must be based on data supplied by the game administrator before playing. However, game reports should indicate whether plans have been realised.

3.6 Scrap machines (SCRAP)

With the **SCRAP** instruction, machines purchased in preceding quarters can be scrapped. Accordingly, it cannot be used in the first quarter. A machine should be scrapped when its repair costs surpass its utility. Expected repair costs may be computed from the data specified in section 3.5. Actual repair cost may be given in the report. If a machine is not in use, it is scrapped at the start of the quarter, otherwise it is scrapped when the job using it is finished. The machines to be scrapped are selected with a set selection instruction from a list containing machine numbers (see 3.5):

```
1 2 3

SCRAP MACHINES
```

3.7 Design a product (DESIGN)

The **DESIGN** instruction uses the following screen format:

PRODUCT	TECHNOLOGY	TECHNOLOGY	TECHNOLOGY	TECHNOLOGY	REMARKS
P1					TECHNOLOGY UNKNOWN
P2	SPECA	TRADA			DIFFERENT INDUSTRIES
P3	TECHA	TECHC			DIFFERENT QUALITY
P4	TRADA				

```
DESIGN NEW PRODUCT
```

The **DESIGN** instruction adds a new product and defines one or more technologies to produce it. The technologies define the industry and the quality index of the product. If more than one technology is specified, those should be in the same industry and have the same quality index. When applied to an existing product, the **DESIGN** instruction can be used to add or remove a technology. For example, a labour-intensive technology may be replaced by a capital-intensive technology when labour has become expensive. Production can start when characteristics have been defined for the product (see 3.9). If production is to order, orders can be taken immediately; deliveries have to wait until the first batch is produced. A product can be removed (see 3.8) when it no longer contributes to company profits. Technologies are described in section 2.5, actual data on technologies are given in section 5.4.

3.8 Remove a product (REMOVE)

Products to be removed are selected by set selection:

```
P1 P2 P5

REMOVE PRODUCT
```

When the **REMOVE** instruction is given for a product, the product is actually removed when all current production orders for it have been executed. If production is both for stock and to order, all current consumer orders are reviewed in simple sequential fashion and if possible filled from stock. Products in stock that cannot be sold in this way, including all products in industries with production for stock only, are dumped without cost or income. In industries with production to order only, all existing consumer orders are filled before the product is actually removed. If a product is removed and the machine needed to produce it are scrapped at the same time, the machines are actually scrapped after the current production job (see 3.6). Consequently, the remaining production orders for this product will never be executed.

3.9 Define product characteristics (PRODP)

The screen format for the **PRODP** instruction is:

PRODUCT	DELIVERY	REORDER LEVEL	ORDER QUANT	MAXTIME	PRICE	ADV BUDGET
P1	10	2000	1000	8	200	100 000
P2	0			60	100	
P5	0			60	100	

SET PRODUCT PARAMETERS

For each product the following variables must be defined:

Column	Description
PRODUCT	Product name
DELIVERY	Quoted delivery time in days[1]
REORDER LEVEL	Reorder level for a new production order[1,2]
ORDER QUANT	Order quantity: size of production order[1,2]
MAXTIME	Maximum time for a production order
PRICE	Selling price[1]
ADV BUDGET	Advertising budget[1]

1 Not applicable for materials
2 Not applicable for production to order

Selling price, advertising budget, quoted delivery time and credit extended to customers (see 3.15) determine how many customers will be attracted to the product. If production is to order only, the consumer order will be stored and executed as soon as resources for production are available, unless it is cancelled beforehand. When the job is finished, it will be delivered to the consumer. If production is for stock, a production order for the number of units defined in ORDER QUANT is given when the stock falls below the amount defined in REORDER LEVEL. The value of ORDER QUANT cannot be set below an industry-specific minimum. However, because unfilled orders are subtracted from the stock, REORDER LEVEL may be set to 0 in industries where back-orders are accepted. If back-orders are accepted, they are filled when a production order is finished. However, back-orders are annulled when the promised delivery date has passed and this will influence the market image of the producer. MAXTIME defines the maximum time

allowed for production of a batch. When used in industries with production to order only, it can prevent production of orders that take too long; in industries that produce for stock, it can reduce batch size (see 2.5). Production of materials is governed by the rules for material supply (see 3.10). The product is not sold to third parties and the amount produced is immediately added to the stock of the corresponding material.

3.10 Set parameters for materials (MAT)

Data are entered for the **MAT** instruction with the following screen format:

MATERIAL	REORDER LEVEL	ORDER QUANT	REMARKS
100	4000	2000	
120	3000	1500	
150	1000	500	UNKNOWN MATERIAL

SET PARAMETERS FOR MATERIALS

The player should provide all materials needed for production, either by internal production or by appointing external suppliers. When the stock of a material falls below REORDER LEVEL, an order will be placed with a selected supplier (see 3.11) or a production order will be given. The size of this order is equal to ORDER QUANTITY. The value of ORDER QUANTITY cannot be lower than the lowest minimum order size accepted by any supplier of the material (see 3.11). Orders are given as long as the stock minus the amount needed for planned production orders plus the unfilled orders for the material is below the specified reorder level.

3.11 Choose suppliers (SUPPL)

Suppliers for materials are chosen from a list of suppliers provided by the game administrator. For a material produced internally, the name of the company itself must

be entered. If there is more than one supplier for a material, orders are given in round-robin fashion. Suppliers are chosen with the following table instruction:

MATERIAL	SUPPLIER	SUPPLIER	SUPPLIER	SUPPLIER	REMARKS
100 120 160	S1 S2 ABC	S1			INCORRECT SUPPLIER

SELECT SUPPLIERS

The choice of suppliers is determined by the materials they supply, the terms for those materials, and the general terms of the supplier. For each supplier the list of suppliers contains the following variables (see 5.6 for values):

Attribute	Description
Name	Unique name of a supplier
Credit	Number of days of credit extended by the supplier
Maximum	Maximum amount of credit extended by the supplier
Discount	Discount given by supplier for immediate payment

The list of materials contains the following variables (see 5.6 for values):

Attribute	Description
Name	Name of supplier
Material	Quality index of material
Price	Price per unit
Mean	Mean time to deliver
Std	Standard deviation of delivery time (delivery time is normally distributed)
Min order	Minimum order size

3.12 Define terms for employees (EMP)

The **EMP** instruction uses the following screen format:

MIN EMP	MAX EMP	SALARY
100	120	2 500

SET TERMS FOR EMPLOYEES

The following variables are set for all employees of the company:

Attribute	Description
Min emp	Minimum number of employees. If the actual number of employees is smaller, employees will be hired.
Max emp	Maximum number of employees. If the actual number is larger, employees will be fired
Salary	Salary (including all benefits) per month

The success of a company in hiring and retaining employees depends on its relative salary and its recent employment history. Hiring starts at the beginning of the quarter. Employees are fired at the start of the last month of the quarter, so they have time to look for new jobs. Employees who find new jobs are not considered fired. The labour market is described in section 2.6. Data are given in section 5.2.

3.13 Ask loans (BANK)

The **BANK** instruction is a table instruction with the following format. The bank limit provides credit on call. A loan is repaid in the stated number of quarters.

BANKLIMIT	LOAN AMOUNT	QUARTERS	%	REMARKS
15 000 000	2 000 000	5	2	BANKLIMIT NOT ACCEPTED

ASK LOAN

The application for a bank limit or a loan is accepted if it is not higher than the maximum previously defined by the game administrator. A refusal is displayed in the REMARKS column. The interest percentages per year for loans and for credit on call are also defined by the game administrator (see 5.1). Only the first one is displayed; it is used for identification of loans in the REPAY instruction (see 3.14).

3.14 Repay loans (REPAY)

Loans may be repaid before they are due. This is done with a table instruction with the following format that lists all existing loans. A loan is repaid by entering Y in the REPAY ? column.

NR	AMOUNT	INTEREST	QUARTERS	REPAY ?
1	2 000 000	2	5	

LOAN REPAYMENT

3.15 Accept credit and set credit terms (CREDIT)

The first entry in the **CREDIT** instruction determines by set selection from which suppliers credit is accepted. Accepting credit from suppliers is a means of financing materials stock. Its cost can be computed from the number of days of credit and the discount for immediate payment (see 3.11 for explanation and 5.6 for data). There is an upper bound to the credit extended by each supplier to a single customer. Consequently, a reason not to accept credit is that demand for credit from a particular supplier would surpass the maximum amount extended.

```
S1 S2 S3 S4 S5 S6 S7 S8 S9 S10
ACCEPT CREDITS FROM SUPPLIERS
```

Second, a table instruction is used to define in which industries credit to customers is granted. Credit to customers is a marketing instrument. It entails interest cost, risk and additional clerical costs to trace customer payments as well as deliveries.

TRAD	TECHN	SPEC	ORDER
10	0	0	0

```
USE AND EXTEND CREDIT
```

4 THE REPORT

4.1 File format

INFOMARK produces an ASCII report file "xxxnn.REP", where xxx is the company name, and nn is the number of the quarter. All file records have the following format:

Columns	Type	Attribute
1-8	numeric	time
9-17	string	code
18-26	string	descr1
27-35	string	descr2
36-43	numeric	seqnr
44-58	numeric	amount
59-73	numeric	price

String items start with a letter and are left-aligned. Numeric items are right-aligned with two digits after the decimal point. They contain no other formatting characters. Items with a null value are represented by spaces if followed by a non-null item. The file may contain the following entries:

name	type	explanation
machtype	string	machine type
machnr	string	'MACH' + machine number
prodorder	numeric	sequence number of production order
consorder	numeric	sequence number of consumers order
matororder	numeric	sequence number of material order
machorder	numeric	sequence number of machine order
reporder	numeric	sequence number of repair order
loannr	numeric	sequence number of loan
technology	string	name of technology
product	string	product name
industry	string	industry name
supplier	string	supplier name
material	string	'MAT' + material quality index
consumer	string	'C' + consumer number
employee	numeric	Social security number of employee
price	numeric	price per unit
time	numeric	number of days,months or quarters
number	numeric	number of units
amount	numeric	Monetary amount

4.2 Instruction data

All instructions are copied without cost into the data file. If the actual execution of an instruction may be delayed or cancelled, the corresponding actual event may be recorded separately (see 4.3).

name	descr1	descr2	seqnr	amount	price	instruction
invest	machtype		machorder	$amount_1$		INVEST
plscrap	machtype	machnr				SCRAP
design	product	technology				DESIGN
addproc	product	technology				DESIGN
delproc	product	technology				DESIGN
plrem	product	technology				REMOVE
addsup	supplier	material				SUPPL
delsup	supplier	material				SUPPL
setprod	product		$time_2$	$amount_3$	$amount_4$	PRODP
setprice	product		$time_5$	price	$amount_6$	PRODP
setmat	material			$amount_3$	$amount_4$	MAT
planhf				$number_7$	$number_8$	EMPL
setsal				$amount_9$		EMPL
takecred	supplier					
givecred	industry		$time_{10}$			
limit				$amount_{11}$		BANK
getloan			loannr	$amount_{12}$	$quarters_{13}$	BANK
planrepl			loannr			REPAY

1) Price of machine
2) Maximum time (in days) for production run
3) Reorder level
4) Order quantity
5) Quoted delivery time in days
6) Advertising budget
7) Minimum number of employees
8) Maximum number of employees
9) Salary per month
10) Number of days of customer credit in this industry
11) Bank limit granted
12) Size of loan
13) Number of quarters in which loan must be repaid

4.3 Events

The events that can be reported are listed in the following table:

name	descr1	descr2	seqnr	amount	price	Explanation
matorder	supplier	material	matorder	number	price	material ordered
mat	supplier	material	matorder	number	price	material delivered
nomat	supplier	material	matorder	number	price	material not delivered
paymat	supplier		matorder	amount		material paid
alloc	product	material	prodorder	number		material allocated
use	product	material	prodorder	number		material used
order	product	consumer	consorder	number	price	order by consumer
prodqueu	product	technology	prodorder	number		queue production order
prodord	product	technology	prodorder	number		production order
prodrdy	product	technology	prodorder	number		finish production order
deliver	product	consumer	consorder	number	price	product delivered
nodeliv	product	consumer	consorder	amount	price	product not delivered
salepay	product	consumer	consorder	amount		payment by consumer
salary				amount		salary paid
advert	product			amount		advertising paid
remove[1]	product			number		remove product
install	machtype	machnr	machorder	amount		machine installed
noinst	machtype		machorder	amount		machine not installed
machall	product	machnr	prodorder	number		machines allocated
machfree	product	machnr	prodorder	number		machines freed
scrap	machtype	machnr				machines scrapped
defect	machtype	machnr	reporder			machines defective
repair	machtype	machnr	reporder	amount		machines repaired
interest				amount		interest paid
interest				0	amount	interest received
interest			loannr	amount		loan interest paid
reploan			loannr	amount	time[2]	loan repaid
account[3]				amount		accounting costs paid
assignw	product		prodorder	number		employees assigned
freework	product		prodorder	number		employees freed
hirecost				amount		personnel advertising
firecost				amount		redundancy costs
hire	company[4]		employee			employee hired
fire			employee			employee fired
leave	company[4]		employee			employee leaves

1 Number is the number of units dumped without income

2 In quarters

3 Always reported without cost

4 Only if employee is hired from or leaves for competing company.

4.4 Inventories

The following inventories can be made:

name	descr1	descr2	seqnr	number	amount	description
mats	material			number		stock of material
ps	product					stock of product
machw	machtype	machnr	prodorder			machines in use
machnu	machtype			$number_1$	$number_2$	machines not in use
pers				number		employees
ops	product		prodorder	number		active operators
$cash_3$				amount		cash balance
$cash_3$				0	amount	overdraft

1 Total number of machines of this type that are not in use

2 Number of machines of this type in repair

3 Reported daily without cost

4.5 Data analysis with DBASE3

Though the report file can also be analyzed with programs in conventional languages, such as BASIC or Pascal, DBASE3 and similar packages are most appropriate for such programs. Accordingly, our examples are in DBASE. First, a DBASE file must be created with the following format:

FIELD_NAME	FIELD_TYPE	FIELD_LENGTH	FIELD_DEC
TIME	N	8	2
CODE	C	9	0
DESCR1	C	9	0
DESCR2	C	9	0
SEQNR	N	8	0
AMOUNT	N	15	2
PRICE	N	15	2

Next, data should be entered from the ASCII file. If the ASCII file is called ABC1.REP (this is the report of company "ABC" for the first quarter) and the DBASE file ABC1.DBF, this is done with:

```
. USE ABC1
. APPEND FROM ABC1.REP SDF
```

Now we can use direct statements or programs to extract data from the DBASE file. For example, a direct query to compute the total value of deliveries is:

```
. USE ABC1
. SUM AMOUNT*PRICE FOR CODE='deliver'
```

The stock of finished products at the end of the first quarter is computed by:

```
. USE ABC1
. LIST DESCR1,AMOUNT FOR CODE='ps'.AND.TIME=60
```

The result is:

```
RECORD#   DESCR1          AMOUNT
    633   TRADA         7222.00
    634   TRADD          375.00
    635   SPECE         1988.00
```

4.6 Data analysis with Lotus 1-2-3

To use the report file in Lotus 1-2-3, it should be read in with an Import Text command. Then column A1.. should be parsed to columns B1..H1 with the following parsing line:

```
|V>>>>>>*L>>>>>>>*L>>>>>>>*L>>>>>>>*V>>>>>>>*V>>>>>>>>>>>>>*V>>>>>>>>>>>>>*
```

After that, the original column A may be deleted, and the contents of the spreadsheet are:

Column	A	B	C	D	E	F	G
Contents	time	code	descr1	descr2	seqnr	amount	price

A typical Lotus application first computes the amounts of backorders and stocks in H2 and I2 respectively with the formulas:

```
H2: @IF($B2="order",H1-$F2,@IF($B2="nodeliv"#OR#$B2="deliver",H1+$F2,H1))
I2: @IF($B2="deliver",I1-$F2,@IF($B2="prodrdy",I1+$F2,I1))
```

Assuming that the rows 1..750 are filled, the contents of H2..I2 are then copied to H2..I750, and an XY graph showing back-orders and stocks can be plotted with X = A2..A750, A = H2..H750 and B = I2..I750.

4.7 Market report

The market report contains all product offers as well as the selection of one product for each consumer demand. A demand is not entered in the file if all products are too expensive, if no product is known to consumer or if the promised delivery time of all products is too high. The market report also contains data on deliveries and order annulments by customers. The file format is:

Columns	Type	Attribute		
1-8	numeric	Time		
9-10	string	Code		
11-19	string	Product		
20-28	string	Company		
		Code = P	Code = A	Code ¯ {O,S.D.N}
29-33	numeric	Quality		Sequence number
34-38	numeric			Consumer number
39-48	numeric	Price	Advertising budget	Amount

4.8 Labour market report

The labour market report contains a monthly statement of the number of employees and the salary per employee for each company, as well as the number of unemployed persons and the unemployment benefit. The report format is:

Column	Type	Contents
1-8	numeric	Time
9-17	string	Company (or UNEMPLD)
18-25	numeric	Number of employees or unemployed persons
26-33	numeric	Salary or unemployment benefit

5 EXTERNAL DATA

External data are supplied by the game administrator in the ASCII files INFOGAME.TXT and INFOGAME.LIS (see 6.2). The contents of this chapter should correspond to the contents of those files. If players are encouraged to use these data for decision making, the data should be made available to them in machine-readable format, for example in database or spreadsheet files. The game administrator's manual contains instructions for changing data.

Table 5.1 General data

Labour market data	
Fraction of labour force departing each month	0.01
Hiring cost per worker	500
Available workers at the start of the game	500
Productivity of new workers	0.5
Learning factor per month	0.3
Minimum wage per month	2000
Unemployment benefit per month	1000
Redundancy payment in months	1
Miscellaneous data	
Starting capital in millions of ECU	10
Yearly interest percentage for credit balance	4
Yearly interest percentage for debit balance	8
Yearly interest percentage for bank loans	8

Table 5.2 Data for consumer industries

		Industry			
		TRAD	TECHN	SPEC	ORDER
Base price		100	100	100	100
Minimum delivery time		0	10	10	15
Maximum delivery time		0	20	20	30
Stock possible		Y	Y	Y	N
Number of consumers		50	50	50	50
Reference group		low	medium	high	medium
Advertising budget		high	low	medium	medium
Average paytime		0	5	8	10
Maximum paytime		40	50	55	50
Minimum batch size		100	200	100	
Interarrival time	Starting value	12	50	24	18
	Reduction per period	0.01	0.015	0.02	0
	Cycle	0.1	0.3	0.25	0.1
	Cycle length	20	20	20	20
Order size	Starting value	240	1000	480	360
	Reduction per period	0	0.005	0.002	0.02
	Cycle	0	0.1	0.05	0.25
	Cycle length	20	20	20	20

Table 5.3 Technology data

Name	Industry	Machine	Qual	Workers	Capacity	Set-up	Materials			
							Qual	Amount	Qual	Amount
MATX	MAT	M1	110	25	20000	0.5	100	18000	120	2000
MATY	MAT	M2	110	20	60000	4	100	60000		
TRADA	TRAD	M3	100	60	20000	1	120	20000		
TRADB	TRAD	M4	100	40	40000	2	110	30000	140	10000
TRADC	TRAD	M3	150	40	10000	1	120	5000	160	5000
TRADD	TRAD	M5	200	60	10000	3	110	2000	160	8000
TECHA	TECH	M3	100	80	40000	1	140	40000		
TECHB	TECH	M6	100	60	100000	4	110	60000	120	40000
TECHC	TECH	M7	150	40		2.5	110	20000	160	20000
TECHD	TECH	M3	200	50	40000 20000	1	160	20000		
SPECA	SPEC	M3	100	80	30000	1	140	30000		
SPECB	SPEC	M8	100	80	60000	3	110	40000	120	20000
SPECC	SPEC	M9	150	50	30000	3	110	10000	160	20000
SPECD	SPEC	M3	200	50	15000	1	160	15000		
ORDA	ORDER	M3	100	40	20000	1.5	140	20000		
ORDB	ORDER	M10	100	60	60000	0.2	110	40000	120	20000
ORDC	ORDER	M3	200	90	20000	1.5	160	20000	160	30000
ORDD	ORDER	M10	200	75	40000	0.2	110	10000		

Table 5.4 Machine data

Name	MTTD	Repair cost/day	Investment	MTBF	MTTR	δ
M1	6	2000	1000000	30	2	0.05
M2	30	5000	6000000	150	10	0.04
M3	5	3000	2000000	30	3	0.08
M4	10	1800	6000000	100	5	0.06
M5	22	2200	2500000	200	10	0.08
M6	15	6000	10000000	250	4	0.07
M7	15	4000	6000000	150	8	0.05
M8	10	4500	7000000	150	5	0.05
M9	10	2500	4000000	200	6	0.05
M10	12	5000	6000000	150	4	0.06

Table 5.6 Supplier data

Supplier	Material	Max credit		Discount	Price	Delivery time		Min order size
		Days	Amount			Mean	Stddev	
S1	100	20	1500000	0.01	12	10	2	100
S2	100	30	2000000	0	14	0	0	100
S3	110	0	2000000	0	60	0	0	1000
S4	120	0	2000000	0	28	0	0	1000
S5	120	20	1500000	0.01	25	12	2	100
S6	120	30	2000000	0	24	18	8	100
S7	140	20	1500000	0.01	34	14	3	100
S8	140	30	2000000	0	32	20	8	100
S9	140	0	1500000	0	36	0	0	100
S10	160	0	2000000	0	46	0	0	100
S11	160	20	1500000	0.01	44	15	2	100
S12	160	30	2000000	0	42	22	10	100

Table 5.6 Cost of measuring data

Event data	Inventory data	Free data
100	2000	0

6 GAME ADMINISTRATOR'S INSTRUCTIONS

6.1 Directories

Infogame is a Turbo-Pascal (Rev 6.0) program for the IBM-PC and compatibles. It can be played on a stand-alone PC (with hard disk) or a PC-network under Novell or Banyan Vines. Before loading the program and data files, a subdirectory INFOGAME must be created. Within this subdirectory, a separate subdirectory is created for each *world*, i.e. each group of competing companies. Within a world subdirectory, subdirectories are created for each company. The name of a company subdirectory must be the same as the name of a company. A diagram of the structure is given in fig 6.1

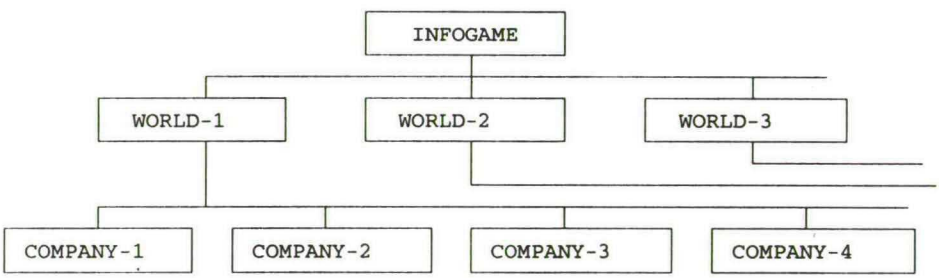


Fig 6.1: Directory structure

The game administrator must have access to all directories. Players must have read-write access to the company directory and read access to the pertinent world directory and they must be able to run programs from the Infogame directory.

6.2 Files

The five types of files ar list in Table 6.2:

Table 6.2: File types

Type	Description	Example
P	Program	INFOMARK.EXE
D	Externally prepared data files in ASCII format	INFOGAME.TXT
I	Internal (binary coded) files	INFOGAME.DAT
T	Internal transfer files in ASCII format	INFO1A.TRF
O	Output files in ASCII format	ABC1.REP

Table 6.3 lists all files. The distribution disk contains the files of type P and D; the user should transfer these files to the dedicated partition of the hard disk.

Table 6.3: Infogame files

Name	Type	Directory	Description
INFOGAME.EXE	P	Infogame	Input program for players
INFOMARK.EXE	P	Infogame	Program that computes the results of a round.
INFOBANK.EXE	P	Infogame	Input program for the game administrator.
INFOGAME.TXT	D	World	General data on the environment
INFOGAME.LIS	D	World	Data on suppliers, materials and machines
BANKHELP.TXT	D	Infogame	Help file for INFOBANK
FULLHELP.TXT	D	Infogame	Help file for INFOGAME
INFOGAME.DAT	I	World	General data file
INFOGAME.CNS	I	World	File with consumer data
INFOGAME.EVN	I	World	File with event data
INFOGAME.EMP	I	World	File with employee data
INFOnnA.TRF	T	Company	File with input data prepared by INFOGAME and read by INFOMARK. nn = period number.
xxxnn.REP	O	Company	File with company data produced by INFOMARK. xxx= company name, nn = period number.
xxxnn.REP	O	World	File with market data for a specific industry produced by INFOMARK. xxx=industry name, nn = period number.
LABORnn.REP	O	World	File with labour data produced by INFOMARK. nn = period number.

The relation between files and programs is give in fig 6.4.

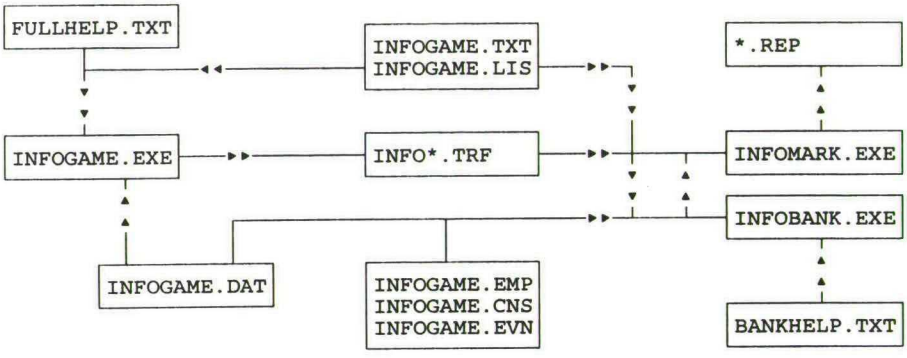


Fig 6.4: Infogame files and programs

6.3 Playing sequence

Normal play proceeds as follows:

a) INFOBANK is called by the game administrator, and the command START is executed (see 6.4)

b) INFOGAME is executed by each player to enter data (see chapter 3). Preferably, INFOGAME is started automatically after a login procedure which provides the only access to Infogame data.

c) INFOMARK is called by the game administrator to compute the results of the round. The only input asked from the game administrator is entry and/or verification of a password.

d) Players analyze data from their private *.REP files and from the market and labour *.REP files. In this phase, the game administrator should prevent write access by players to any file and read access to private files of other companies, for example by providing a program that supplies copies of the *.REP files to players.

e) Players proceed with b) for the next round. Even if no input changes are made, INFOGAME should be called at least once for each player in each round.

Restart of a period is possible at any moment after the first call of INFOMARK. A restart is executed by the game administrator by a call to the RESTART option of INFOBANK (see 6.4). A restart can be used for corrections and for teaching purposes.

6.4 Execution of INFOBANK

INFOBANK uses the selection and table-filling instructions described in chapter 3. Like INFOGAME, INFOBANK asks for entry and/or verification of a password. Thereafter, an instruction is selected. When this has been executed, a new instruction can be selected. Execution of INFOMARK is terminated by pressing F9 or ESC. The select instruction shows the list of options:

```
START RESTART BANKER
CHOOSE INSTRUCTION
```

The available options are:

Option	Description
START	Start a new playing session
RESTART	Restart a former period
BANKER	Banker's instructions

Start a new playing session (START)

After *START*, a new play series is started in round 1. However, existing *.TRF files are not deleted. If the file INFOGAME.DAT does not exist, START is the only option available. In that case the game administrator starts with entry and verification of a new password. If the file INFOGAME.DAT exists, the password of the current playing session must be entered before the new session can start. This is done to prevent accidental use of *START*. If the old password is not known, the file INFOGAME.DAT should be erased.

Restart a former period (RESTART)

After *RESTART*, the appropriate round is selected from a set of options:

```
1 2 3
CHOOSE QUARTER
```

After restart, the input for the indicated period can be corrected with INFOGAME, and the results can be computed again with INFOMARK. *.TRF files for later periods are not deleted.

Banker's instructions (BANKER)

After *BANKER*, the game administrator can select one of two options:

```
MAXIMA RATES
SELECT RULE
```

With the option *MAXIMA* the banker defines the maximum short-time limit and the maximum amount of long term loans for each existing company. Consequently, this option cannot be executed in the first round. The format of the table is:

FIRM	MAX LIMIT	MAX LOAN
ABC	5 000 000	10 000 000

```
SET BANK MAXIMA
```

With the *RATES* option the following rates are set for all companies:

Attribute	Description
SHORT %	Interest percentage (per year) for bank credit
LONG %	Interest percentage (per year) for long-term loans
CREDIT%	Interest percentage (per year) for deposits

The screen format for this instruction is:

SHORT %	LONG %	CREDIT %
8	8	4

```
SET BANK RATES
```

IN 1993 REEDS VERSCHENEN

588 Rob de Groof and Martin van Tuijl
The Twin-Debt Problem in an Interdependent World
Communicated by Prof.dr. Th. van de Klundert

589 Harry H. Tigelaar
A useful fourth moment matrix of a random vector
Communicated by Prof.dr. B.B. van der Genugten

590 Niels G. Noorderhaven
Trust and transactions; transaction cost analysis with a differential behavioral assumption
Communicated by Prof.dr. S.W. Douma

591 Henk Roest and Kitty Koelemeijer
Framing perceived service quality and related constructs A multilevel approach
Communicated by Prof.dr. Th.M.M. Verhallen

592 Jacob C. Engwerda
The Square Indefinite LQ-Problem: Existence of a Unique Solution
Communicated by Prof.dr. J. Schumacher

593 Jacob C. Engwerda
Output Deadbeat Control of Discrete-Time Multivariable Systems
Communicated by Prof.dr. J. Schumacher

594 Chris Veld and Adri Verboven
An Empirical Analysis of Warrant Prices versus Long Term Call Option Prices
Communicated by Prof.dr. P.W. Moerland

595 A.A. Jeunink en M.R. Kabir
De relatie tussen aandeelhoudersstructuur en beschermingsconstructies
Communicated by Prof.dr. P.W. Moerland

596 M.J. Coster and W.H. Haemers
Quasi-symmetric designs related to the triangular graph
Communicated by Prof.dr. M.H.C. Paardekooper

597 Noud Gruijters
De liberalisering van het internationale kapitaalverkeer in historisch-institutioneel perspectief
Communicated by Dr. H.G. van Gemert

598 John Görtzen en Remco Zwetheul
Weekend-effect en dag-van-de-week-effect op de Amsterdamse effectenbeurs?
Communicated by Prof.dr. P.W. Moerland

599 Philip Hans Franses and H. Peter Boswijk
Temporal aggregration in a periodically integrated autoregressive process
Communicated by Prof.dr. Th.E. Nijman

600 René Peeters
On the p-ranks of Latin Square Graphs
Communicated by Prof.dr. M.H.C. Paardekooper

601 Peter E.M. Borm, Ricardo Cao, Ignacio García-Jurado
Maximum Likelihood Equilibria of Random Games
Communicated by Prof.dr. B.B. van der Genugten

602 Prof.dr. Robert Bannink
Size and timing of profits for insurance companies. Cost assignment for products with multiple deliveries.
Communicated by Prof.dr. W. van Hulst

603 M.J. Coster
An Algorithm on Addition Chains with Restricted Memory
Communicated by Prof.dr. M.H.C. Paardekooper

604 Ton Geerts
Coordinate-free interpretations of the optimal costs for LQ-problems subject to implicit systems
Communicated by Prof.dr. J.M. Schumacher

605 B.B. van der Genugten
Beat the Dealer in Holland Casino's Black Jack
Communicated by Dr. P.E.M. Borm

606 Gert Nieuwenhuis
Uniform Limit Theorems for Marked Point Processes
Communicated by Dr. M.R. Jaïbi

607 Dr. G.P.L. van Roij
Effectisering op internationale financiële markten en enkele gevolgen voor banken
Communicated by Prof.dr. J. Sijben

608 R.A.M.G. Joosten, A.J.J. Talman
A simplicial variable dimension restart algorithm to find economic equilibria on the unit simplex using $n(n+1)$ rays
Communicated by Prof.Dr. P.H.M. Ruys

609 Dr. A.J.W. van de Gevel
The Elimination of Technical Barriers to Trade in the European Community
Communicated by Prof.dr. H. Huizinga

610 Dr. A.J.W. van de Gevel
Effective Protection: a Survey
Communicated by Prof.dr. H. Huizinga

611 Jan van der Leeuw
First order conditions for the maximum likelihood estimation of an exact ARMA model
Communicated by Prof.dr. B.B. van der Genugten

612 Tom P. Faith
Bertrand-Edgeworth Competition with Sequential Capacity Choice
Communicated by Prof.Dr. S.W. Douma

613 Ton Geerts
The algebraic Riccati equation and singular optimal control: The discrete-time case
Communicated by Prof.dr. J.M. Schumacher

614 Ton Geerts
Output consistency and weak output consistency for continuous-time implicit systems
Communicated by Prof.dr. J.M. Schumacher

615 Stef Tijs, Gert-Jan Otten
Compromise Values in Cooperative Game Theory
Communicated by Dr. P.E.M. Borm

616 Dr. Pieter J.F.G. Meulendijks and Prof.Dr. Dick B.J. Schouten
Exchange Rates and the European Business Cycle: an application of a 'quasi-empirical' two-country model
Communicated by Prof.Dr. A.H.J.J. Kolnaar

617 Niels G. Noorderhaven
The argumentational texture of transaction cost economics
Communicated by Prof.Dr. S.W. Douma

618 Dr. M.R. Jaïbi
Frequent Sampling in Discrete Choice
Communicated by Dr. M.H. ten Raa

619 Dr. M.R. Jaïbi
A Qualification of the Dependence in the Generalized Extreme Value Choice Model
Communicated by Dr. M.H. ten Raa

620 J.J.A. Moors, V.M.J. Coenen, R.M.J. Heuts
Limiting distributions of moment- and quantile-based measures for skewness and kurtosis
Communicated by Prof.Dr. B.B. van der Genugten

621 Job de Haan, Jos Benders, David Bennett
Symbiotic approaches to work and technology
Communicated by Prof.dr. S.W. Douma

622 René Peeters
Orthogonal representations over finite fields and the chromatic number of graphs
Communicated by Dr.ir. W.H. Haemers

623 W.H. Haemers, E. Spence
Graphs Cospectral with Distance-Regular Graphs
Communicated by Prof.dr. M.H.C. Paardekooper

624 Bas van Aarle
The target zone model and its applicability to the recent EMS crisis
Communicated by Prof.dr. H. Huizinga

625 René Peeters
Strongly regular graphs that are locally a disjoint union of hexagons
Communicated by Dr.ir. W.H. Haemers

626 René Peeters
Uniqueness of strongly regular graphs having minimal p-rank
Communicated by Dr.ir. W.H. Haemers

627 Freek Aertsen, Jos Benders
Tricks and Trucks: Ten years of organizational renewal at DAF?
Communicated by Prof.dr. S.W. Douma

628 Jan de Klein, Jacques Roemen
Optimal Delivery Strategies for Heterogeneous Groups of Porkers
Communicated by Prof.dr. F.A. van der Duyn Schouten

629 Imma Curiel, Herbert Hamers, Jos Potters, Stef Tijs
The equal gain splitting rule for sequencing situations and the general nucleolus
Communicated by Dr. P.E.M. Borm

630 A.L. Hempenius
Een statische theorie van de keuze van bankrekening
Communicated by Prof.Dr.Ir. A. Kapteyn

631 Cok Vrooman, Piet van Wijngaarden, Frans van den Heuvel
Prevention in Social Security: Theory and Policy Consequences
Communicated by Prof.Dr. A. Kolnaar

IN 1994 REEDS VERSCHENEN

632 B.B. van der Genugten
Identification, estimating and testing in the restricted linear model
Communicated by Dr. A.H.O. van Soest

633 George W.J. Hendrikse
Screening, Competition and (De)Centralization
Communicated by Prof.dr. S.W. Douma

634 A.J.T.M. Weeren, J.M. Schumacher, and J.C. Engwerda
Asymptotic Analysis of Nash Equilibria in Nonzero-sum Linear-Quadratic Differential Games. The Two-Player case
Communicated by Prof.dr. S.H. Tijs

635 M.J. Coster
Quadratic forms in Design Theory
Communicated by Dr.ir. W.H. Haemers

636 Drs. Erwin van der Krabben, Prof.dr. Jan G. Lambooy
An institutional economic approach to land and property markets - urban dynamics and institutional change
Communicated by Dr. F.W.M. Boekema

637 Bas van Aarle
Currency substitution and currency controls: the Polish experience of 1990
Communicated by Prof.dr. H. Huizinga

638 J. Bell
Joint Ventures en Ondernemerschap: Interpreneurship
Communicated by Prof.dr. S.W. Douma

639 Frans de Roon and Chris Veld
Put-call parities and the value of early exercise for put options on a performance index
Communicated by Prof.dr. Th.E. Nijman

640 Willem J.H. Van Groenendaal
Assessing demand when introducing a new fuel: natural gas on Java
Communicated by Prof.dr. J.P.C. Kleijnen

641 Henk van Gemert & Noud Gruijters
Patterns of Financial Change in the OECD area
Communicated by Prof.dr. J.J Sijben

642 Drs. M.R.R. van Bremen, Drs. T.A. Marra en Drs. A.H.F. Verboven
Aardappelen, varkens en de termijnhandel: de reële optietheorie toegepast
Communicated by Prof.dr. P.W. Moerland

643 W.J.H. Van Groenendaal en F. De Gram
The generalization of netback value calculations for the determination of industrial demand for natural gas
Communicated by Prof.dr. J.P.C. Kleijnen

644 Karen Aardal, Yves Pochet and Laurence A. Wolsey
Capacitated Facility Location: Valid Inequalities and Facets
Communicated by Dr.ir. W.H. Haemers

645 Jan J.G. Lemmen
An Introduction to the Diamond-Dybvig Model (1983)
Communicated by Dr. S. Eijffinger

646 Hans J. Gremmen and Eva van Deurzen-Mankova
Reconsidering the Future of Eastern Europe: The Case of Czecho-Slovakia
Communicated by Prof.dr. H.P. Huizinga

647 H.M. Webers
Non-uniformities in spatial location models
Communicated by Prof.dr. A.J.J. Talman

648 Bas van Aarle
Social welfare effects of a common currency
Communicated by Prof.dr. H. Huizinga

649 Laurence A.G.M. van Lent
De winst is absoluut belangrijk!
Communicated by Prof.drs. G.G.M. Bak

650 Bert Hamminga
Jager over de theorie van de internationale handel
Communicated by Prof.dr. H. Huizinga

651 J.Ch. Caanen and E.N. Kertzman
A comparison of two methods of inflation adjustment
Communicated by Prof.dr. J.A.G. van der Geld

652 René van den Brink
A Note on the τ-Value and τ-Related Solution Concepts
Communicated by Prof.dr. P.H.M. Ruys

653 J. Engwerda and G. van Willigenburg
Optimal sampling-rates of digital LQ and LQG tracking controllers with costs associated to sampling
Communicated by Prof.dr. J.M. Schumacher

654 J.C. de Vos
A Thousand Golden Ten Orbits
Communicated by Prof.dr. B.B. van der Genugten

655 Gert-Jan Otten, Peter Borm, Stef Tijs
A Note on the Characterizations of the Compromise Value
Communicated by Prof.dr. A.J.J. Talman

656 René Peeters
On the p-ranks of the adjacency matrices of distance-regular graphs
Communicated by Dr.ir. W.H. Haemers

657 J. Kriens, L.W.G. Strijbosch, J. Vörös
Differentiability Properties of the Efficient (μ, σ^2)-Set in the Markowitz Portfolio Selection Method
Communicated by Prof.dr. A.J.J. Talman

658 Prof.dr. E.J. Bijnen and dr. M.F.C.M. Wijn
Corporate Prediction Models, Ratios or Regression Analysis?
Communicated by Prof.dr. W. van Hulst

659 Edwin R. van Dam
Regular graphs with four eigenvalues
Communicated by Dr.ir. W.H. Haemers

660 G.J. van der Pijl
Quality of information and the goals and targets of the organization: a model and a method
Communicated by Prof.dr. P.M.A. Ribbers

661 Jan van der Leeuw
The second derivative of the likelihood of an exact ARMA model
Communicated by Dr. H.H. Tigelaar

662 Jan van der Leeuw, Harry Tigelaar
An asymptotic justification for a modified GLS procedure to estimate ARMA parameters
Communicated by Prof.dr. B.B. van der Genugten

663 H.M. Webers
The location model with two periods of price competition
Communicated by Prof.dr. A.J.J. Talman

664 L.A.G.M. van Lent
Management accounting en stroomsgewijze produktie
Communicated by Dr. M.F.C.M. Wijn

665 Noud Gruijters
Financiële integratie, de prijsbenadering en rente-arbitrage
Communicated by Prof.dr. J.J. Sijben

666 Henk van Gemert
Monetaire conflicten en de integratiegeschiedenis van België en Nederland
Communicated by Prof.dr. J.J. Sijben

667 Rik G.M. Pieters and Tammo H.A. Bijmolt
The effect of duration, serial-position and competitive clutter on consumer memory for television advertising: an extension and a test of generalizability
Communicated by Prof.dr. Th.M.M. Verhallen

668 Dr. M.F.C.M. Wijn, Drs. W.A. Hofenk, Drs. R.W. Hoekstra en M.B. Hengeveld
Kritische succesfactoren aan een nadere analyse onderworpen
Communicated by Prof.dr. R. Bannink

669 Drs. N.B. Brentjens en Drs. J. Bell
Samenwerking in de detailhandel: Theorie en praktijk
Communicated by Prof.dr. S.W. Douma

670 Masakiyo Miyazawa & Gert Nieuwenhuis
Modified Palm and modified time-stationary distributions for random measures and applications
Communicated by Prof.dr.ir. O. Boxma

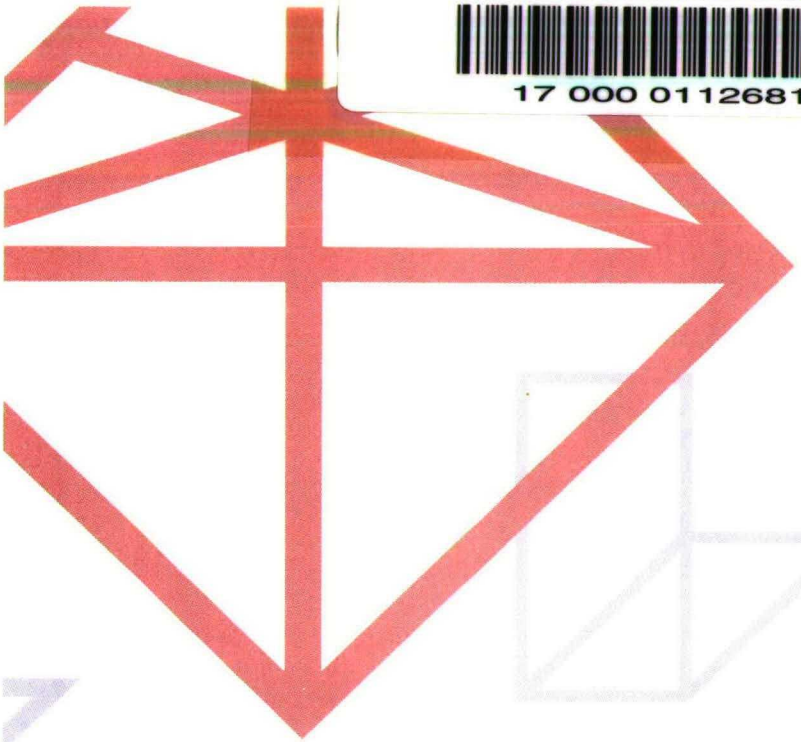
671 Noud Gruijters
Kapitaalrestricties, renteverschillen en valutaspeculatie
Communicated by Prof.dr. J.J. Sijben

672 Jacob C. Engwerda en Arie J.T.M. Weeren
On the relationship between the open-loop Nash equilibrium in LQ-games and the inertia of a matrix
Communicated by Prof.dr. J. Schumacher

673 Tom Berglund
The Pricing of Initial Public Offerings: A Simple Model
Communicated by Prof.dr. P.W. Moerland

674 Erik Canton
The OECD 1951-88 Growth Experience Revisited
Communicated by Prof.dr. A.B.T.M. van Schaik

675 Willem H. Haemers
Interlacing Eigenvalues and Graphs
Communicated by Prof.dr. M.H.C. Paardekooper



Katholieke Universiteit Brabant
PO Box 90153
5000 LE Tilburg
The Netherlands